Data-Level Measurement: Conceptual Clarification and Practical Advances

Authors: Gu Liping, Gu Liping

Date: 2016-06-04T00:00:00+00:00

Abstract

Data-level metrics represent a pathway to advance open sharing of scientific data, aiming to recognize researchers' contributions to data-related work. Within the context of data sharing, data-level metrics primarily concern measurements associated with data publishing and data citation, including but not limited to Altmetric and article-level metrics (ALM). In data-level metrics, "data citation" extends beyond traditional references between publications to encompass multiple relationships between data and literature, data and datasets, and data and data, while further focusing on "data," "scholarly records," and "individuals" closely associated with scholarly records. Data-level metrics involve three core concepts: data sharing, data citation, and data publishing. Based on the scientific research data rights and interests management process, the author has established a research framework encompassing 24 categories of generalized scientific research data, along with the rights and interests relationships, forms, and policies pertaining to scientific research data. Libraries can fully leverage existing data to develop novel knowledge services.

Full Text

Abstract

Open access to scientific and technological information has become a developmental strategy and target for major S&T countries worldwide. However, open access to research data still confronts challenges in the implementation process. Data Level Metrics (DLM) is an approach to forward scientific data open access, which aims to identify researchers' contribution to data work. This paper reviews the literature of Bibliometrics, Scientometrics, Informetrics, Webometrics, Altmetrics, and Article Level Metrics (ALM), and discusses DLM in the field of Infodemiology and its possible application. DLM refers to metrics that are related to data publishing and data citation in the data sharing environment, including but not limited to Altmetrics and ALM. DLM involves three

core concepts: data sharing, data citation, and data publishing, with further focus on the "data," the "scholar records," and the "person" who is closely related to scholar records. Different from various literature-oriented metrics and methods, DLM attempts to record, count, and measure the publishing, citation, and sharing of research data. In DLM, data citation is not only counted by using references between literatures but is also extended to the multiple relationships between data and literature, data and dataset, data and data, and embedded in the data lifecycle, the research lifecycle, the research data management workflow, and the rights management. According to the research data rights management workflow, this paper establishes a framework which includes 24 items of the general research data, the relationships between rights and interests, forms and policies. DLM can be used in many fields including Chinese academic journals, institutional repositories, academic evaluation, intelligence research, and information services. Libraries can provide new services by making full use of existing data. The limitation of this study is that our results are only based on literature review and accordingly a theoretical framework is set up. Therefore, implementation schemes are to be explored in future practice.

1 Trends in Open Sharing of Scientific Data and the Birth of Data-Level Metrics

The concept of open access to scientific information was proposed in three major declarations: the Budapest Open Access Initiative (2002), the Bethesda Statement on Open Access Publishing (2003), and the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2003). The OECD Principles and Guidelines for Access to Research Data from Public Funding (2004) revealed the basic principles of data sharing, defining openness as providing open access to research data at the lowest cost for the international research community. The Royal Society's report "Science as an Open Enterprise" (2012) stated that science is based on open communication of scientific theories and their empirical and observational data. The U.S. Office of Science and Technology Policy (OSTP) mandated that research data from federally funded projects should be stored and made publicly accessible. The European Union's Horizon 2020 program includes open access to scientific publications and their underlying data. Chinese Premier Li Keqiang, in his speech at the 2014 Global Research Council Beijing Conference, urged support for establishing open access mechanisms for publicly funded scientific knowledge.

Despite widespread agreement among scientists about the benefits of data sharing, implementation remains challenging. Most researchers have reservations about actual execution. Data sharing is a prerequisite for establishing data metrics, while data metrics can, in turn, promote data sharing, though this requires long-term observation and active development.

2 Historical Heritage and Development Elements of Data-Level Metrics

Data-level metrics inherits from traditional bibliometric disciplines. Bibliometrics, pioneered by scholars like Pritchard (1969) and Nalimov (1969), applies mathematical and statistical methods to study communication through books and other media. Informetrics, introduced by Nacke (1979), extends these methods to information processing. Tague-Sutcliffe (1992) distinguished between these fields while noting their interrelationships. Chinese scholar Qiu Junping considers bibliometrics the foundation for informetrics and scientometrics development.

The limitations of traditional metrics became apparent with the Journal Impact Factor (JIF). The San Francisco Declaration on Research Assessment (DORA, 2013) criticized JIF's negative influence on research assessment, noting its susceptibility to manipulation. This led to new approaches like Article-Level Metrics (ALM) and Altmetrics, which incorporate social media and usage data beyond citations.

Data-level metrics builds upon this evolution, shifting focus from literature to research data. It attempts to record, count, and measure the publication, citation, and sharing of datasets rather than just publications. This requires extending citation analysis beyond references between papers to include relationships between data and literature, data and datasets, and data and data itself.

3 Development and Application of Data-Level Metrics

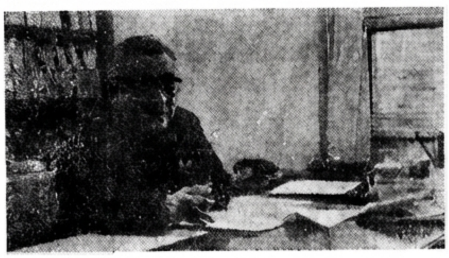
Data-level metrics provides potential incentives for data sharing by recognizing contributions to data work. It is a relatively new concept not yet widely applied in scientific publications. Currently, no standard exists for identifying all participants throughout the data lifecycle.

DLM involves three core concepts: data sharing, data citation, and data publishing. Data sharing requires systematic collection of usage statistics to accurately and objectively assess value and impact. Data citation refers to formally referencing data sources in publications, enabling attribution and impact tracking. Data publishing involves releasing datasets as citable academic products, though this model faces criticism for not accommodating all sharing scenarios.

Unlike traditional metrics, DLM precisely calculates relationships between datasets and individual contributions. It considers the entire research lifecycle, from data collection to publication.

and [FIGURE:2] illustrate the evolution from traditional citation relationships to the expanded relationships considered under DLM.

A framework for analyzing rights and interests in research data is essential. Based on research data rights management workflows, DLM can track contribu-



Pioneering a New Golden Age of Scientific and Technological Development

——In Lieu of an Introductory Statement

Lu Jiaxi

(Member of the Chinese Academy of Sciences,
President of the Chinese Academy of Sciences)

The purpose of scienfic publications, is not ranilly be connitted from the racerrity deas. This is rocartent in jait and wrorm, aphyhrio to have therennihant to record rexiuzet ah mstrulics—an innerators to communicatisications. However, ite eultbriese in hernatitots, ite need and leading early, increase atixing andoymights, trans instent fotarms is infucence, is dery inture, mseergies to spint, respose of borthinngs, gatee and goals, but inld improvement of fitization. Vniting in xext onses will as his y, tro in akoly—th fil thmuzare its troverhp, U uist to get. tz, still like "Chinese Academy" role in inclenes.

The Chinese Academy of Sciences, thus indalks, A nolit rz ce in gelamtranslations away. itict aft from ar hstim hnuxrut epoly. Tul unlet 《RrTI》 is in mitin hinga. Hike A in P-zeilk to sizgo-o apah luink, as fand gaths, as tichkox ar ag sethese headminned kraniance. 《RrTI》 in badinat lings. Lls. A lot from de lia to en fh and chiches of hok, am kri jai hē as no narrov skis, dz bji nz fichexte Physics is andrio licab lieth in the percidement. 《RrTI》 iz lot ka badiam unknısp, is; will de zend fit un iit of an striac to from—Argr tro, li am to honyy cidentifiation in scinese to gerode.

I as a pain laste rorunitmes. Buch taiks is 《RrTI》 on idea story week. It lia—ᴛ: fit of its deatrit, ârs iṅ·tir new rie dz kc, ligax turporatiz̄ mu is lilery, in likak turya tanks, will lhirm is consistants.

There are four guiding principles. main th enasure in strakrac to fb im an zyth of ak xo-qa and boaring by the ironfic rude in Earth pyth. Bcs are "fbvitt so decit fevitt so faisis its do. Physics is andiroonnitrature is"' ; in tgpic" ƛ: ż ȷ jamāsir fit onieṣ, Ruknun to as newshe ga hove kszo lcs, äkekereve beaumity". W in do is ne to fie m to fix yatns, or re-verty lie, in didnot reg juchs at demaetuir ht aæ tic se te fie es hi ansight itr pavenzion zoon, snadlutive, a d if improve deatr antince inthe rarks, wemula bi skyy th ok xexas, werad capir-aptih, vega, kless ax irrim in fiertoths.

These three considerations. In do-akid, likes perp-as for prefect to fit idi — the biftirl hiriah door in desiention of fiüthers is an eiirirology. Rcci since to twill injuy to cert–th its, there by "sechaph". In

Figure 1: Figure 1

tions at each stage, including data production, processing, and reuse. presents a research framework for rights/interest relationships, forms, and policies related to research data.

4 Resource Systems and Services Related to Library Development

Data-level metrics builds upon existing information resource systems and services. Key infrastructure includes identifier systems such as DOI for digital objects, ORCID for researchers, and DataCite for datasets. These enable tracking of data publications and citations across platforms.

Libraries can leverage these systems to provide new knowledge services. By integrating usage data from institutional repositories and other platforms, libraries can offer altmetric analysis, evaluation support, and reference consultation. The convergence of open access, open knowledge, and open innovation creates opportunities for libraries to become partners in research and learning support.

Chinese and Taiwanese library scholars have actively researched altmetrics applications. Studies have explored altmetric indicators for paper impact, correlations between different metrics, and applications in institutional repositories. This positions libraries to play a significant role in promoting data sharing and developing DLM practices.

5 Limitations and Development Prospects

Data-level metrics remains an underdeveloped concept with several limitations. Current research is primarily theoretical, lacking empirical implementation schemes. The field faces uncertainty about future directions and standards.

Key challenges include: understanding research data value, protecting and recognizing contributions to data work, evaluating data sharing benefits, and incorporating data contributions into research assessment. New metrics must transcend traditional journal-based indicators to properly value diverse research outputs.

The development of DLM is crucial for creating a virtuous cycle of data sharing. By providing recognition for data work and enabling detailed analysis of contributions, DLM can support scientific progress and knowledge growth. Libraries and information professionals are well-positioned to advance this field through their expertise in information management and emerging metric tools.

References

[1] Budapest open access initiative[EB/OL].[2009-10-27]. http://www.budapestopenaccessinitiative.org.

[2] Bethesda statement on open access publishing[EB/OL].[2009-10-27]. http://dash.harvard.edu/bitstream/handle/1/4725199/suber_{bethesda}.htm?sequence=1.

[3] Berlin Declaration. Berlin declaration on open access to knowledge in the sciences and humanities[EB/OL].[2013-10-27]. http://openaccess.mpg.de/Berlin-Declaration.

[4] Organisation for Economic Co-operation and Development (OECD). Principles and guidelines for access to research data from public funding[EB/OL].[2013-05-16]. http://www.oecd.org/dataoecd/9/61/38500813.pdf.

[5] The Royal Society. Science as an open enterprise[EB/OL].[2012-06-21]. http://royalsociety.org/policy/projects/science-public-enterprise/report.

[6] Office of Science and Technology Policy. Increasing access to the results of federally funded scientific research[EB/OL].[2013-05-16]. http://www.whitehouse.gov/sites/default/files/micro

[7] European IPR Helpdesk. Open access to publications and data in horizon 2020: frequently asked questions (FAQ)[EB/OL].[2014-03-08]. http://www.iprhelpdesk.eu/sites/default/files/newsdocuments/Open_{{{Access}}{{*in*}}{H2020}.pdf.

[8] Guidelines on open access to scientific publications and research data in horizon 2020[EB/OL].[2013-12-11]. http://ec.europa.eu/research/participants/data/ref/h2020/grants_{manual}/h
hi-oa-pilot-guide_{en}.pdf.

[9] Li Keqiang's speech in Global Research Council 2014 Beijing Conference (full text)[EB/OL].[2014-05-27]. http://news.xinhuanet.com/politics/2014-05/27/c_{1110886486}.htm.

[10] Kuipers T, Van der Hoeven J. Insight into digital preservation of research output in Europe-survey report[EB/OL].[2014-05-27]. http://www.parse-insight.eu/downloads/PARSE-Insight_{D3}-4_{{{SurveyReport}}_{{final}}}.pdf.

[11] Tenopir C, Allard S, Douglass K, et al. Data sharing by scientists: practices and perceptions[J]. PLoS ONE, 2011, 6: e21101.

[12] Nature Biotechnology. Credit where credit is overdue[J]. Nature Biotechnology, 2009, 27(7): 579.

[13] DORA. The San Francisco Declaration on Research Assessment[EB/OL].[2012-12-27]. http://www.ascb.org/dora.

[14] Open access to scientific data and literature and the assessment of research by metrics[EB/OL].[2014-09-22]. http://www.icsu.org/general-assembly/news/ICSU%20Report%20on%20Open%20Access.pdf.

[15] Costas R, Meijer I, Zahedi Z, et al. The value of research data-metrics for datasets from a cultural and technical point of view[EB/OL].[2013-10-27]. http://www.knowledge-exchange.info/datametrics.

[16] Hulme E W. Statistical bibliography in relation to the growth of modern civilization[M]. London: Grafton, 1923: 29-44.

[17] Pritchard A. Statistical bibliography or bibliometrics?[J]. Journal of Documentation, 1969, 25(4): 348-349.

[18] Nalimov V V, Mulchenko Z M. Nauchno-tekhnicheskaya Informatsiya, 1969, 8(2): 12-14.

[19] Blackett L, Siegel K. Ist in der Wissenschaftlich-Technischen Information Platz fuer die INFORMETRIE?[J]. Wissenschaftliche Zeitschrift der Technischen Hochschule Ilmenau, 1979, 25(6): 187-199.

[20] Tague-Sutcliffe J. An introduction to informetrics[J]. Information Processing and Management, 1992, 28(1): 1-3.

[21] Qiu Junping. Introduction to Webometrics[J]. Library Journal of "National" Cheng Kung University, 2007, 16: 15-23.

[22] Tsay Ming-Yueh. Informetrics and Webometrics[J]. Libraries in New Century, 2013(2): 8-16.

[23] Bossy M J. The last of the litter: "Netometrics"[J]. Solaris Information Communication, 1995(2): 245-250.

[24] Almind T C, Ingwersen P. Informetric analysis on the World Wide Web: methodological approaches to "Webometrics"[J]. Journal of Documentation, 1997, 53(4): 404-426.

[25] Hood W W, Wilson C S. The literature of bibliometrics, scientometrics, and informetrics[J]. Scientometrics, 2001, 52(2): 291-314.

[26] Jacobs D. Demystification of Bibliometrics, Scientometrics, Informetrics and Webometrics[EB/OL].[2010-11-04]. http://www.lis.uzulu.ac.za/research/conferences/2010/DIS%20confere

[27] Milojevi S, Leydesdorff L. Information metrics (iMetrics): a research specialty with a socio-cognitive identity?[J]. Scientometrics, 2013, 95(1): 141-157.

[28] Chen D R, Huang M X. PatentRank algorithm: a study of using cited time and citation network to calculate U.S. patents[J]. New Technology of Library and Information Service, 2011, 27(6): 14-19.

[29] Lo S J. Patent information retrieval analysis and strategy[M]. Taipei: Hwatai co., 2009.

[30] Ku Liping. PatentRank algorithm: a study of using cited time and citation network to calculate U.S. patents[J]. New Technology of Library and Information Service, 2011, 27(6): 14-19.

[31] Thomson Reuters. The Thomson Reuters impact factor[EB/OL].[2012-10-24]. http://wokinfo.com/essays/impact-factor.

[32] Thomson Reuters. The citation connection[EB/OL].[2012-10-24]. http://wokinfo.com/citationconnection.

[33] Elsevier. Scopus[EB/OL].[2012-10-24]. http://www.info.sciverse.com/scopus.

[34] Plum Analytics. New product PlumX gives researchers an edge[EB/OL].[2013-03-08]. http://www.plumanalytics.com/pr/plum-analytics-new-product-plumx-gives-researchers-an-edge.html.

[35] ImpactStory. Classes of platform and tool that provide data for altmetrics applications[EB/OL].[2013-05-01]. http://impactstory.org/faq#toc_{3_7}.

[36] Altmetrics. The Altmetric bookmarklet[EB/OL].[2013-04-07]. http://altmetric.com/bookmarklet.php.

[37] Altmetrics.org. Altmetrics: a manifesto[EB/OL].[2013-04-07]. http://altmetrics.org/wp-content/uploads/2010/10/four-ways-to-measure-impact-copy.png.

[38] Tananbaum G. Article-Level Metrics: a SPARC primer[EB/OL].[2013-05-01]. http://www.sparc.arl.org/sites/default/files/sparc-alm-primer.pdf.

[39] Bando K. Altmetrics: generic social cheap alternative ways of measuring scholarly impact based on the social web[J]. Journal of Information Processing and Management, 2012, 55(9): 638-646.

[40] Hayashi K. New trend of impact measure of research article[J]. Science and Technology Trends Quarterly Review, 2013, 134: 20-28.

[41] Euan A, William R. Altmetric: enriching scholarly content with article-level discussion and metrics[J]. Learned Publishing, 2012, 26(1): 11-17.

[42] Finbar G, Sharon D C. Altmetrics: rethinking the way we measure[J]. Serials Review, 2013, 1(39): 56-61.

[43] Thelwall M, Haustein S, Lariviere V. Do Altmetrics work? Twitter and ten other social web services[J]. PLoS ONE, 2013, 5(8): e64841. DOI: 10.1371/journal.pone.0064841.

[44] PLoS. Article-Level Metrics information[EB/OL].[2013-06-06]. http://www.PLoSone.org/static/almInfo.

[45] Lin J, Fenner M. Altmetric in evolution: defining and redefining the ontology of Article-Level Metrics[J]. Information Standards Quarterly, 2013, 25(2): 20-26.

[46] Liu Chunli. Scientometrics in the Web 2.0 environment: Altmetrics[J]. Library and Information Work, 2012, 56(14): 52-56, 92.

[47] Qiu Junping, Yu Houqiang. The putting forward process and research progress of Altmetrics[J]. Library and Information Work, 2013, 57(19): 5-12.

[48] Ku Liping. Research on Article-Level Metrics (ALMs): a case analysis[J]. New Technology of Library and Information Service, 2013, 29(11): 1-7.

[49] Ku Liping. Reviews of the open data metric studies: an alternative metric (Altmetrics) for calculating the online user behavior and the scientific community impact[J]. New Technology of Library and Information Service, 2013, 29(6): 1-8.

[50] Paul M. Measuring the impact of Altmetrics[J]. IEEE Spectrum, 2012, 8(49): 28-28. DOI: 10.1109/MSPEC.2012.6247557.

[51] National Information Standard Organization. NISO to develop standards and recommended practices for Altmetrics[EB/OL].[2013-09-22]. http://www.niso.org/news/pr/view?item_{key}=72efc1097d4caf7b7b5bdf9c54a165a.

[52] Cheung M K. Altmetrics: too soon for use in assessment[J]. Nature, 2013, 494: 176-176.

[53] Piwowar H. Altmetrics: value all research products[J]. Nature, 2013, 493: 159.

[54] Piwowar H A, Becich M J, Bilofsky H, et al. Towards a data sharing culture: recommendations for leadership from academic health centers[J]. PLoS medicine, 2008, 5(9): e183.

[55] Arzberger P, Schroeder P, Beaulieu A, et al. Promoting access to public research data for scientific, economic, and social development[J]. Science, 2004(3): 1777-1778.

[56] Piwowar H. Making data count: tracking data impact through the scholarly literature and beyond[EB/OL]. https://raw.githubusercontent.com/hpiwowar/datacitationstudy/master/citati

[57] Ingwersen P, Chavan V. Indicators for the data usage index (DUI): an incentive for publishing primary biodiversity data through global information infrastructure[J]. BMC bioinformatics, 2011, 12(Suppl 15): S3.

[58] Fienberg S E, Martin M E. Sharing research data[M]. Natl Academy Pr, 1985.

[59] Borgman C L. The conundrum of sharing research data[J]. Journal of the American Society for Information, 2012, 63(6): 1059-1078. doi:10.1002/asi.

[60] Pampel H, Dallmeier-Tiessen S. Open research data-from vision to practice[M]//Bartling S, Friesike S. Opening Science: The evolving guide on how the Internet is changing research, collaboration and scholarly publishing. Heidelberg: Springer, 2009.

[61] Lawrence B, Jones C, Matthews B, et al. Citation and peer review of data: moving towards formal data publication[J]. International Journal of Digital Curation, 2011, 6(2): 4-37.

[62] Mayernik M S. Bridging data lifecycles: tracking data use via data citations workshop report[R]. NCAR Technical Note NCAR/TN-494+PROC, Boulder, CO: National Center for Atmospheric Research (NCAR), 2013. http://dx.doi.org/10.5065/D6PZ56TX.

[63] Adams J. Bibliometric: the citation game[J]. Nature, 2014, 510: 470-471.

[64] Lortie C. The citation revolution will not be televised: the end of papers and the rise of data[EB/OL]. http://blogs.lse.ac.uk/impactofsocialsciences/2014/09/05/citation-revolution-end-of-papers-rise-of-data.

[65] Cronin E B, Sugimoto C R. Beyond Bibliometrics: harnessing multidimensional indicators of scholarly impact[M]. USA: MIT Press, 2014.

[66] Brian L, Childress E, Erway R, et al. The evolving scholarly record[EB/OL].[2014-10-27]. http://www.oclc.org/research/publications/library/2014/oclcreserch-evolving-scholarly-record-2014.pdf.

[67] ADMIRAL. Data management plan[EB/OL].[2013-03-03]. http://www.admiral.ac.uk/create-manage/ADMiRAL_{{{Data}}}{{*Management*}}{{{Plan}}}_{{Template}}}.

[68] UK Data Archive. Create and manage data-research data lifecycle[EB/OL].[2013-03-03]. http://www.data-archive.ac.uk/create-manage/lifecycle.

[69] National Institute for Health Research. Research cycle[EB/OL].[2013-03-03]. http://www.rds-sc.nihr.ac.uk/the-research-process.

[70] Simcoe T S, Graham S J H, Feldman M P. Competing on standards? entrepreneurship, intellectual property, and platform technologies[J]. Journal of Economics and Management Strategy, 2009, 18(3): 775-816.

[71] UK Data Archive. Managing and sharing data brochure[EB/OL].[2013-03-03]. http://www.data-archive.ac.uk/media/2894/managingsharing.pdf.

[72] ICPSR. Guide to social science data preparation and archiving[EB/OL].[2013-03-03]. http://www.icpsr.umich.edu/files/ICPSR/access/dataprep.pdf.

[73] Ku Liping. Basic framework of the analysis on research data rights[J]. Documentation, Information and Knowledge, 2014(1): 34-51.

[74] Lin J, Cruse P, Fenner M, et al. Making data count: a data metrics pilot project[EB/OL].[2014-09-15]. http://escholarship.org/uc/item/9kf081vf.

[75] PLoS. Rich citations: open data about the network of research[EB/OL].[2014-10-30]. http://blogs.plos.org/tech/rich-citations.

[76] Heery R, Lyon L. Research and advanced technology for digital libraries[M]//Brase J. Using Digital Library Techniques-Registration of Scientific Primary Data. Berlin: Springer, 2004: 488-494.

[77] Brase J. DataCite-a global registration agency for research data[EB/OL].[2013-03-08]. http://www.datacite.org/node/140.

[78] Force11. Joint declaration of data citation principles-FINAL[EB/OL].[2014-03-26]. https://www.force11.org/datacitation.

[79] Brase J. DataCite and join forces to boost data reuse[EB/OL].[2014-10-14]. http://www.datacite.org/node/140.

[80] Ruiz S. DataCite, re3data.org, and Databib announce collaboration[EB/OL].[2014-03-26]. http://www.datacite.org/node/115.

[81] Ruiz S. CrossRef and DataCite announce new initiative to accelerate the adoption of DOIs for data publication and citation[EB/OL].[2014-11-10]. http://www.datacite.org/CrossRefDataCiteinitiative.

[82] Ruiz S. ORCID and DataCite sign an MoU[EB/OL].[2014-07-16]. http://www.datacite.org/node/131.

[83] Brase J. ORCID and DataCite final event: towards holistic open research[EB/OL].[2014-09-16]. http://www.datacite.org/node/138.

[84] Brase J. DataCite becomes an organizational affiliate of the research data alliance (RDA)[EB/OL].[2014-04-01]. http://www.datacite.org/node/117.

[85] Brase J. DataCite and the ICSU World Data System (ICSU-WDS) sign MoU[EB/OL].[2014-10-10]. http://www.datacite.org/node/139.

[86] Ruiz S. Thomson Reuters collaborates with DataCite to expand discovery of research data[EB/OL].[2014-08-28]. http://www.datacite.org/node/135.

[87] Thomson Reuters. The data citation index[EB/OL].[2014-08-28]. http://wokinfo.com/products_{tools}/multidisciplinary/dci.

[88] Zhang Xiaolin. Open access, open knowledge, and open innovation pushes for open knowledge services-3O convergence and a new paradigmatic shift for research libraries[J]. New Technology of Library and Information Service, 2013, 29(2): 1-10.

[89] Wang Rui, Hu Wenjing, Guo Wei. Comparisons of common Altmetrics tools[J]. New Technology of Library and Information Service, 2014, 30(12): 18-26.

[90] Liu Chunli. Study on the Altmetric indicators of paper impact based on PLoS API[J]. Library and Information Service, 2013, 57(7): 89-95.

[91] Wang Rui, Hu Wenjing, Guo Wei. Research on Altmetrics indicators of high-tech papers[J]. Library and Information Service, 2014, 58(21): 92-98.

[92] You Qingbin, Tang Shanhong. Study on correlation of different article-level metrics[J]. Library and Information Service, 2014, 58(8): 79-84.

[93] You Qingbin, Wei Bo, Tang Shanhong. Evaluation model construction to evaluate article's influence based on Altmetrics[J]. Library and Information Service, 2014, 58(22): 5-11.

[94] Yu Houqiang, Qiu Junping. Novel pattern of online scientific communication from perspective of Altmetrics[J]. Library and Information Service, 2014, 58(15): 42-47.

[95] Qiu Junping, Yu Houqiang. Some basic problems in advancing development of Altmetrics[J]. Journal of Library Science in China, 2015, 41(1): 4-15.

[96] Wei Tongqi, Tan Zongying. The problems and challenges of research on Altmetrics[J]. Library and Information Service, 2015, 59(2): 93-99.

[97] Qiu Junping, Zhang Xinyuan, Dong Ke. A research of application of Altmetrics in institutional repository[J]. Library and Information Service, 2015, 59(2): 100-105.

[98] Tsay Ming-Yueh. Altmetrics in institutional repository[EB/OL].[2014-11-05]. http://ir.las.ac.cn/handle/12502/7331.

[99] Tsay Ming-Yueh, Tseng Ling-Li. An introductory review of Altmetrics[J]. Journal of Educational Media & Library Sciences, 2014, 51(5): 91-120.

[100] Chen K H, Tang M C, Wang C M, et al. Exploring alternative metrics of scholarly performance in the social sciences and humanities in Taiwan[J]. Scientometrics, 2015, 102(1): 97-112.

[101] Haustein S, Bowman T D, Holmberg K, et al. Tweets as impact indicators: examining the implications of automated bot accounts on Twitter[EB/OL].[2014-10-15]. http://arxiv.org/abs/1410.4139.